IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of:	Alessio Miliani et al
Title:	Assembly System of a Thermocouple For a Gas Turbine
Serial No.:	filed concurrently
Art Unit:	n/a
Filing Date:	filed concurrently
Examiner:	n/a
Date:	June 21, 2006

INFORMATION DISCLOSURE STATEMENT

Mail Stop Patent Application
Commissioner for Patents
PO Box 1450
Alexandria, VA 22313-1450

Sir:

The following are submitted in the above application in compliance with 37 CFR 1.97 and 37 CFR 1.98.

[X] 1. A list of documents on Form PTO-1449 or Substitute together with copies of each identified document (other than U.S. patents and U.S. patent application publications unless required by the Office) and a translation thereof or a concise explanation of each non-English language document or a Search Report or communication from a non-US patent office or an International Search Report from an International Searching Authority for a patent application filed via the Patent Cooperation Treaty or document(s) cited in the application or the priority application.

This paper is submitted in accordance with:

[X] 2. 37 CFR 1.97(b): [within three months of national, non-CPA filing, prior to first Office Action, on the merits, or prior to first office action after filing an RCE]

[ ] 3. 37 CFR 1.97(c): [before Final Office Action, Allowance, or other action closing prosecution, whichever is earlier]; and

[ ] a. The required Certification made in item 5 below; or

[ ] b. The $180.00 fee specified in 37 CFR 1.17(p) for submission of this Information Disclosure Statement is authorized in item 6 below.

[ ] 4. 37 CFR 1.97(d): [on or before issue fee payment]; and

a) The required Certification is stated in item 5 below; and

b) The $180.00 fee specified in 37 C.F.R. 1.17(p) for submission of this Information Disclosure Statement is authorized in item 6 below.

[ ] 5. Certification

[ ] a. Each item of information contained in this Statement was first cited in any communication from a foreign patent office in a counterpart foreign patent application not more than three months prior to the filing of this Statement; or

[ ] b. No item of information contained in this Statement was cited in a communication from a foreign patent office in a counterpart foreign patent application and, to the knowledge of the person signing this document after making reasonable inquiry, no item of information contained in this Statement was known to any individual designated in 37 CFR 1.56(c) more than three (3) months prior to the filing date of this Statement.

[X] 6. Payment of all applicable fees:

☒ Please charge all applicable fees associated with the submittal of this Information Disclosure Statement to Deposit Account No. 090470.

☐ Enclosed is a check in the amount of $__________in payment of all applicable fees associated with the submittal of this Information Disclosure Statement.

This document is submitted in duplicate.

Respectfully submitted,

Mark A. Conklin
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PTO/SB/08A (07-05)
Approved for use through 07/31/2006. OMB 0651-0031
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Substitute for form 1449/PTO

INFORMATION DISCLOSURE STATEMENT BY APPLICANT

(Use as many sheets as necessary)

Sheet | | of | |

Complete if Known	
Application Number	
Filing Date	
First Named Inventor	Alessio Milliani
Art Unit	
Examiner Name	
Attorney Docket Number	72NP154554

U. S. PATENT DOCUMENTS

Examiner Initials*	Cite No.[1]	Document Number Number-Kind Code[2] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages or Relevant Figures Appear
		US-5253190A	10-12-1993	Srinivasan et al	
		US-3623367A	11-30-1971	Benedict	
		US-4605315A	08-12-1986	Kokoszka et al	
		US-4047379A	09-13-1977	Brookes et al	
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FOREIGN PATENT DOCUMENTS

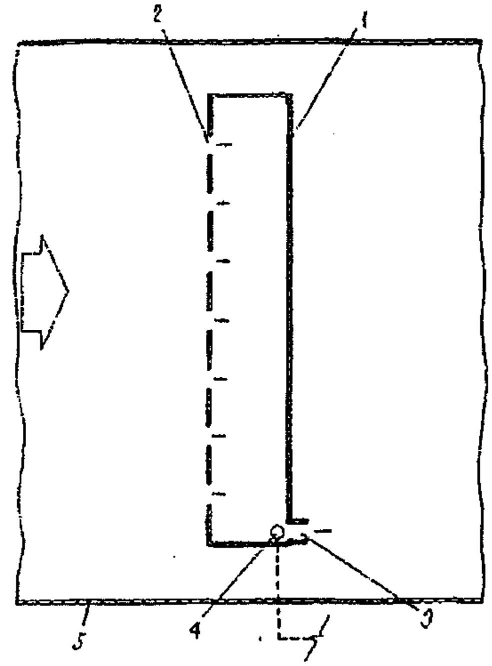
Examiner Initials*	Cite No.[1]	Foreign Patent Document Country Code[3] -Number[4] -Kind Code[5] (if known)	Publication Date MM-DD-YYYY	Name of Patentee or Applicant of Cited Document	Pages, Columns, Lines, Where Relevant Passages Or Relevant Figures Appear	T[6]
		JP 61241633 A	10-27-1986	Matsushita Electric Ind		
		GB 784 597 A	10-09-1957	Cantlin et al		

Examiner Signature		Date Considered	

*EXAMINER: Initial if reference considered, whether or not citation is in conformance with MPEP 609. Draw line through citation if not in conformance and not considered. Include copy of this form with next communication to applicant. [1] Applicant's unique citation designation number (optional). [2] See Kinds Codes of USPTO Patent Documents at www.uspto.gov or MPEP 901.04. [3] Enter Office that issued the document, by the two-letter code (WIPO Standard ST.3). [4] For Japanese patent documents, the indication of the year of the reign of the Emperor must precede the serial number of the patent document. [5] Kind of document by the appropriate symbols as indicated on the document under WIPO Standard ST.16 if possible. [6] Applicant is to place a check mark here if English language Translation is attached.

EUROPEAN PATENT OFFICE

Patent Abstracts of Japan



PUBLICATION NUMBER : 61241633
PUBLICATION DATE : 27-10-86

APPLICATION DATE : 19-04-85
APPLICATION NUMBER : 60083701

APPLICANT : MATSUSHITA ELECTRIC IND CO LTD;

INVENTOR : GOTO YUICHI;

INT.CL. : G01K 13/02 F24F 11/02 G01N 25/64

TITLE : DETECTOR

ABSTRACT : PURPOSE: To detect average property of fluid by letting the fluid flowed in from plural inflow ports of a fluid duct flow out from an outflow port utilizing pressure difference and detecting property of the fluid by a detecting element provided near the outflow port.

CONSTITUTION: The device is provided with a fluid duct 1, plural inflow ports 2 provided opposite to the flow and an outflow port opened in the direction of the flow, and a detecting element 4 is provided near the outflow port. As the pressure of the inflow port 2 is opposite to the direction of flow, it becomes higher than that of the outflow port by the value of dynamic pressure of the flow. Accordingly, air flowed in from plural inflow ports by pressure difference is mixed in the duct 1, and even if temperature of the air at inflow ports is different, it becomes an average state of temperature near the outflow port, and discharged from the outflow port 3. Consequently, by installing a detecting element 4 at this position, average temperature can be detected easily by a detecting element.

PATENT SPECIFICATION

784,597

Date of Application and filing Complete Specification: Aug. 22, 1955.

No. 24181/55.

Application made in United States of America on Aug. 23, 1954.

Complete Specification Published: Oct. 9, 1957.

Index at acceptance:—Class 40(1), N3S7A1.

International Classification:—G08c.

COMPLETE SPECIFICATION

Improvements in or relating to Gas Temperature Sensing Unit or Probe of Thermocouple Type

We, JOHN HENRY CANTLIN and ERIC ERNEST ANDERSON, citizens of the United States of America, of 30 Byron Road, Short Hills, State of New Jersey, United States of America, and at 53 Manning Street, Needham Heights, Commonwealth of Massachusetts, United States of America, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to gas temperature sensing units or so-called probes of the thermocouple type. An object of the invention is to prolong the useful life of such devices, particularly as applied to vibration-subject installations, as in the operative control of jet engines and gas turbines, by providing therefor means to damp and suppress vibration amplitude, and accordingly markedly improving the resistance to mechanical failure under vibration of, and associated with, the probe and its mount.

According to the invention there is provided a gas temperature probe assembly of the thermocouple type, comprising an elongated probe body supporting and insulating thermocouple wires which form a thermocouple junction, and a supporting member adapted for rigid mounting and having a through bore receiving one end portion of the probe body, the bore having at the portion thereof toward the junction end of the probe body a concentric flaring mouth through which the probe body freely projects and which is arranged to afford, at the open mouth end, substantial freedom for vibratory movement to the radially opposite portion of the probe.

In the drawings illustrating one embodiment of the invention:

Figure 1 is a side elevation and longitudinal section of a gas temperature probe assembly, on an enlarged scale at least about twice full size for an average device;

Figure 1A similarly shows a probe tip portion without an impact head about the thermocouple junction;

Figure 1B similarly shows another form of probe tip portion; and

Figure 2 is a further sectional enlargement of the basal or mounting portion of the probe of Figure 1.

A sensing unit or probe of the invention comprises a tubular body or shield 3 having at the free end an impact head 4 rigidly united with the tube as by a circular helium arc weld as at 5. The head is closed at the free end to provide a gas trapping chamber within it. It has a relatively large inlet 6 to face into the high-velocity flow of the gas subject to investigation, and a relatively minute vent 7 spaced axially from the inlet 6 and centrally positioned with respect thereto. In Fig. 1 the vent is shewn dotted, being directly behind and substantially hidden by the thermocouple junction 10. It is to be understood, noting Figs. 1A and 1B again referred to later, that temperature probes of the class concerned may individually differ in various respects such as construction and arrangement for the inner end or tip portion, which latter may or may not include an impact head more or less enclosing the thermocouple junction such as the thermocouple junction 10 of the drawings. The present invention is useful generally with any such probe unit.

A probe as here concerned is adapted for insertion into a duct through which flows gas usually at high temperatures, velocities and pressures, as in the case of the tail pipe or tailcone of a jet engine or gas turbine. Part of a wall of such duct is shown dotted at W in Fig. 1, wherein the assumed direction of gas flow is perpendicular to the sheet and away from the viewer. It will be understood that gas of the stream enters and is trapped in the impact head and is more or less stagnated and caused to follow a tortuous path in escaping through the vent 7.

[Price

The thermocouple or "hot" junction 10 thus is located in the path of the gas entering and passing through the impact head 4 which effectively shields the junction so that heat radiation therefrom to the walls of the jet tail-cone or other gas duct is minimized and hence the thermal condition at the junction 10 will represent a close to true temperature of the gas. The conductor wires 8, 9 from the thermocouple junction 10 extend in insulated condition back through the probe tube 3, all or a major portion of which probe tube out to the impact head 4 preferably contains a ceramic core or filling 11.

The probe elements so far described may be of known construction, that illustrated being in general typical of this class of gas temperature measuring or probing devices. By way of emphasizing the general applicability of the vibration-relieving aspect of the invention to flow-stream inserted or projective probe tubes or sensing units of this thermocouple type, there is illustrated in Fig. 1A, corresponding to the inner or tip portion of Fig. 1, a probe tube 3 without a head or more or less enclosing tip or hood for the thermocouple junction 10, the latter being exposed to the flow under investigation. And Fig. 1B shows the probe tube 3 equipped with a sampling head 4*b* extended and appropriately apertured to sense at different locations in the gas stream.

Much difficulty has been experienced in the use of thermocouple gas probes in and upon gas stream ducts such as those of gas turbines in general, including jet engines. It will be appreciated that the operating conditions there encountered make for vibration of the inwardly projecting probe tube 3, setting up stress particularly at the region of supportive mounting of the probe on the duct wall W. This has frequently resulted in rapid mechanical failure, cracking and ensuing complete rupture of the tube adjacent the duct wall. In accordance with the present invention the amplitude of vibration is materially reduced by incorporating for use with the probe tube 3 a vibrational amplitude suppressing or damping means so shaped, constructed and arranged that the useful life of the device as a whole is importantly prolonged.

Such damping means comprises what may conveniently be termed a "bell-mouth" support or mount indicated generally at 20, of cylindrical form as a whole. It comprises a centrally apertured intermediate body or anchor portion 21, a concentric outer collar or ferrule-like portion 22, and an inner concentric elongated sleeve 23 with an inner bell-mouth end 24 of which the interior wall flares as at 25 toward the sensing end or impact head 4 of the probe. In the preferred construction this flare or bell-mouth 25 may follow, as viewed in central longitudinal section, a rather flat exponential curve or a circular arc of relatively large radius to be further described.

The intermediate body 21 and the inner sleeve 23 of the mount 20 together provide the direct support for the probe tube 3. For that purpose the wall of the bore of said parts 21, 23 from the outer end to an intermediate transverse plane designated by the arrows A—A in Fig. 2 is made straight; that is, as viewed in longitudinal section the wall parallels the straight axis of the bore and is a true cylinder. Along this outer and intermediate section, having the cylindrical bore, which section is indicated by the reference letter *a* on Fig. 2, the bore is dimensioned to receive the corresponding outer end of the probe tube 3 with a tight press fit. Following assembly of the mount 20 on to the probe tube 3 the two are united as by a circular helium arc weld as at 26.

The described portion *a* of the body and sleeve parts 21, 23 of the mount 20 is of a length relative to that of the probe tube 3 to give a firm solid anchorage for the outer end thereof. The section *a* desirably extends at least up to, or somewhat beyond, the inner face of the duct wall W on which the probe is to be mounted.

Beyond the mount section *a*, toward the sensing end or impact head 4 of the probe, the remaining section *b* of the mounting sleeve 23 has the bell-mouth formation referred to, presenting the curvilinear flare 25. The method of constructing this bell-mouth formation 25 will be apparent from the following observations. The inner terminus of the section *a* of the mount sleeve 23, indicated by the arrows A—A may be regarded as the extremity of a cantilever support for the probe tube 3. The curvature radius indicated by the jagged arrow, Fig. 2, is selected to provide a circular arc which is tangential to the straight cylindrical bore in section *a* of the sleeve and which at the inner end 24 of the sleeve will intersect the transverse end face thereof at a radial distance from the tube periphery which is at least equal to or in excess of the lateral traverse of the outer wall of the probe tube at the bell mouth under the maximum expected vibrational displacement of the tube.

On Fig. 2 the upwardly inclined dotted lines represent one extreme vibrational position 3*a* for the probe, and the downwardly inclined lines represent the opposite extreme vibrational position 3*b*. The dot-dash lines 3*ax* and 3*bx* represent the positions of the tube axis at the time of said extreme vibrational positions 3*a* and 3*b* respectively. It will be understood that Fig. 2 is diagrammatic and upon a large scale and that the relative positions may be somewhat exaggerated for clarity. It will be seen thta the bell-mouth-forming flare curve 25 affords at the open end thereof substantial freedom for vibratory action to the radially opposite portion of the probe.

In other words, the amplitude of vibration as designated by the transverse arrow C is less than or does not exceed the total flare at the mouth of the bell; that is, one-half the vibratory amplitude is accommodated by the flare at the upper portion of Fig. 2 and the other half by that at the lower portion. The internal curve or line of flare 25 for the bell-mouth portion *b* may otherwise be defined as an exponential curve, one factor in the equation for which is a radius tangential to the tube at the base of the flared portion *b* and at the junction thereof with the straight cylindrical bore of portion *a*.

It will be noted further that the sleeve portion 23 of the mount is of substantial thickness at the portion *a*, substantially exceeding the metal wall thickness of the probe tube 3 and that, at the opened flared end of the bell portion *b*, the sleeve wall thickness is still at least substantially equal to the probe tube wall thickness.

As a result of the bell-mouthed mount 20 the vibratory action of the probe tube 3 is damped or suppressed progressively along the tube from the open end toward the base of the flare portion *b* of the mount and in such fashion that at the plane A and thence on through the portion *a* thereof, the vibration is approximately zero. Consequently the probe support does not terminate abruptly at the inner face of the wall W of the gas duct. Resultantly the heretofore experienced mechanical failure, cracking or rupture at that region is greatly reduced or practically eliminated.

Turning now to the exterior of the mount 20, the intermediate anchor portion 21 has a reduced inner part 27 to receive a mounting flange 30 fitted tightly thereon and welded to it as at 31. The larger shoulder or outer part 28 of said anchor 21 abuts the outer face of the mounting flange 31 and has the outer collar 22 formed integrally with it.

In the construction of the probe and the mount there is provided for each thermocouple wire 8 and 9 a connection post 12, 13 formed with a central bore through which the wires are passed fully to the outer end where each is trimmed above the respective post and welded to it. Where the probe is of a grounded type only one connector post may be needed; in other instances the thermocouple circuits may involve three or more wires, in which case a like number of posts is provided. The inner ends of the posts such as 12, 13 are formed with retaining heads 12*a*, 13*a*, and the posts are externally threaded for reception of washers and anchor nuts 12*b*, 13*b*. The inner portions of the posts and including a portion of the threading thereof are cast into or extended through a molded mass or block 14 of electrically insulating ceramic material, porcelain or the like. The block 14 and the posts are so dimensioned lengthwise of the probe and the post threading is of such extent that it extends into the ceramic 14 for one or more turns, for firm anchorage. Said ceramic block 14 is formed to fit in the outer collar portion 22 of the probe mount 20 and has an inner peripheral portion to seat against the outer face of the shoulder part 28 of the mount. The outer end of the post-holding ceramic body 14 is reduced to present an inclined annular shoulder between it and the larger inner or base portion, as seen in Fig. 1. In the assembly of the probe device the one or more connection posts such as 12, 13 and the post-holding ceramic block 14 are inserted as a unit into the mount collar 22. The outer peripheral marginal portion 22*a* is then inturned over the shouldered inner portion of the post block 14 after first interposing between the shoulder and the inturned flange 22*a* automatic means for compensating for positional change and stress variation as between the mount 20 and the post block 14 by reason of differential thermal expansion between these parts. Said means comprises at least one annular compensator member or ring 15 shaped and dimensioned for reception between the generally radial but preferably inclined shoulder of the ceramic block 14 and the metal of the flange 22*a* of the mount collar 22. Such compensator ring 15 is fashioned from a spring steel or ferrous alloy such as Inconel and Invar (both Registered Trade Marks), and has a formation such that the difference in thermal expansion between ceramic block 14 which it directly abuts and the metal parts of the mount 20 is compensated for and will preserve at all times a firm and substantially vibration-free tight juncture for the assembled parts throughout the entire expected range of associated operational temperatures. In some instances, more than one such compensator ring may be used or alternatively, as illustrated, a second or filler annulus 16 may be employed for assured engagement and sealing of the parts, such additional washer-like member 16 being located outside the compensator ring 15, between it and the mount flange 22*a*. Said additional annulus 16 if employed need not be of the special composition as for the compensator ring 15 and may, for example, be of an ordinary or relatively soft steel.

A further step in the assembly of the probe and mount is that of filling any remaining cavity within the mount and the inner end of the tube 3 and between the latter and the inserted post-holder block 14. This is accomplished by pressure-filling with a ceramic or cementitious material in plastic state. For this purpose the mount is provided with a pressure-fill aperture 21*x* admitting to the interior of the mount and herein formed through the intermediate body or anchor portion 21 thereof. The interior of the mount is thus

completely and solidly filled, under appropriate pressure, and the filling port 21x sealed off by the filling material itself or otherwise, so that upon setting the entire probe and mount assembly is structurally integrated and resistant to vibrational effects.

The assembled probe unit, including the tube 3, the tube base or mount 20 and the attaching flange 30 are designed for installation on a gas flow wall W such as that of a jet tailcone mentioned. It will be understood that the given wall adjacent which gas temperatures are to be measured is apertured for insertion of the "bell-mouth" probe mount sleeve 22, preferably leaving at least a slight interspace between them. The attaching flange 30 of the mount 20 in the illustrative example has bolt-mounting holes 32 diametrically spaced to opposite sides of the axis of the probe and in a plane accurately normal to the axis of the gas vent 7 and hence also to the direction of gas flow. In other words, the diametral plane containing the center line of the bolt holes 32 for the mounting flange is angularly spaced 90° from the gas vent 7 as shown in the illustrated mount 20. While this is generally preferable, the bolt holes 32 can also be arranged at any other angle in respect to vent 7 in order to facilitate specific mounting requirements.

What we claim is:—

1. A gas temperature probe assembly of the thermocouple type, comprising an elongated probe body supporting and insulating thermocouple wires which form a thermocouple junction, and a supporting member adapted for rigid mounting and having a through bore receiving one end portion of the probe body, the bore having at the portion thereof toward the junction end of a probe body a concentric flaring mouth through which the probe body freely projects and which is arranged to afford, at the open mouth end, substantial freedom for vibratory movement to the radially opposite portion of the probe.

2. A probe assembly according to claim 1, wherein the supporting member has a sleeve and a mounting flange, said sleeve having a straight cylindrical bore portion directly receiving one end of the probe with a press fit and having, in longitudinal continuation of the cylindrical bore portion, the flaring mouth the inner wall of which is tangential to the conjoined end of the cylindrical bore portion.

3. A probe assembly according to claim 2, wherein the sleeve has a relatively thick wall as compared with the probe wall and the mouth flares away from the mounting flange in such a manner that the expectable overall vibrational amplitude for the probe body is accommodated by the flare.

4. A probe assembly according to claim 2 or claim 3 wherein the supporting member comprises a generally cylindrical body having the sleeve at one end in continuation of an intermediate anchor portion carrying the mounting flange and an outer collar portion at the other end housing electrical connections for the thermocouple, the straight cylindrical bore portion in the sleeve being continued through said anchor portion.

5. A probe assembly according to claim 4, wherein the outer collar portion contains a filling of electrically insulating ceramic material for mounting the electrical connections for the thermocouple, the collar including an inturned outer marginal portion, and annular spring means between the ceramic mass and the inturned portion to compensate for thermal expansion differential between said ceramic mass and inturned portion.

6. A probe assembly according to claim 5 wherein the electrical connections for the thermocouple comprises an externally threaded tubular binding post for thermocouple wire connection, the post having an inner portion including a part of the threading embedded in the ceramic mass and an outer portion projecting therefrom, and a thermocouple wire extending outwardly through said mass and the tubular post and conductively bonded thereto at the outer end.

7. A probe assembly according to claim 5 or 6, wherein the spring means comprises a spring metal compensator ring between the ceramic mass and said inturned portion constructed and arranged to compensate for thermal expansion differential between the mass and the collar so as to afford tight juncture of the parts at all times.

8. A probe assembly according to any one of claims 1 to 7, wherein the thermocouple junction is housed in an impact head.

9. A probe assembly according to any one of claims 1 to 7, wherein the thermocouple junction is housed in a sampling head.

10. A probe assembly according to any one of claims 1 to 7, wherein the thermocouple junction is exposed.

11. A gas temperature probe assembly of the thermocouple type having its parts constructed, arranged and adapted to operate substantially as described with reference to the accompanying drawings.

12. Method of manufacturing and assembling gas temperature probes of the thermocouple type having an elongate conductor-carrying body with an outer mounting end, an intermediate portion and a projecting junction or free end, comprising the steps of providing in a mounting member a bore having a straight longitudinal axis, a concentric cylindrical portion and a flaring mouth, and fitting the outer mounting end of the probe body in a firm seating position in the cylindrical bore portion with the intermediate portion extending freely through substantially the entire length of the flaring mouth and with the junction end of the probe body projecting therebeyond.

13. Method according to claim 12, includ-

ing fashioning one or more thermal compensator spring metal rings and disposing the same between axially opposed probe tube mounting members having differential thermal expansion, and selecting the component metal for the ring or rings so as to maintain for said members a firm and substantially vibration-free juncture at all times throughout the entire expected range of associated operational temperatures.

14. Method of manufacturing and assembling gas temperature probes of the thermocouple type substantially as illustrated and described.

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press.—1957.
Published at The Patent Office, 25, Southampton Buildings, London, W.C.2, from which copies may be obtained.

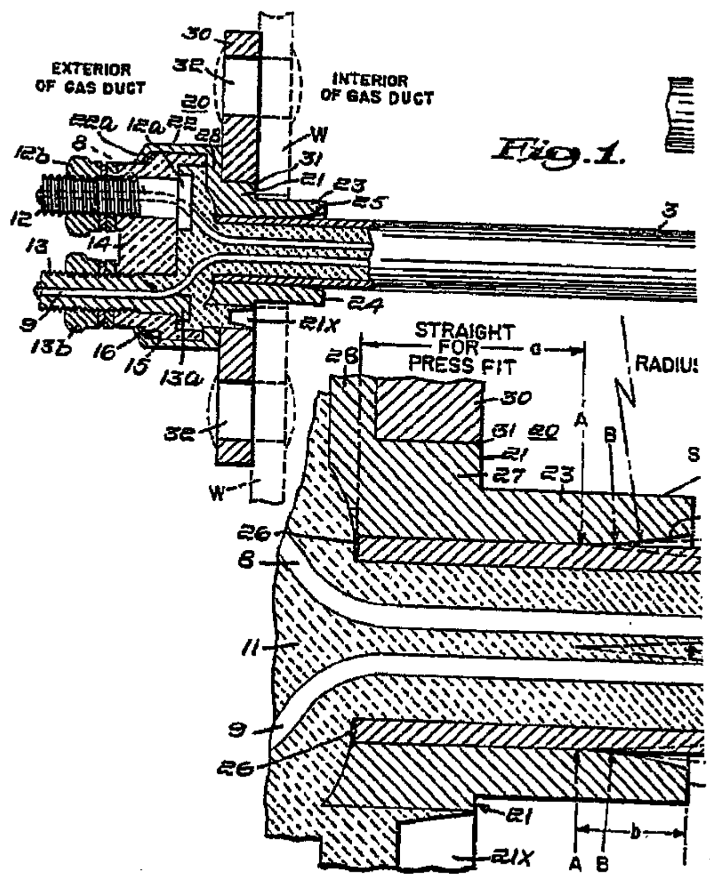
EXTERIOR
OF GAS DUCT
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Fig.1.
STRAIGHT
FOR
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784,597 COMPLETE SPECIFICATION
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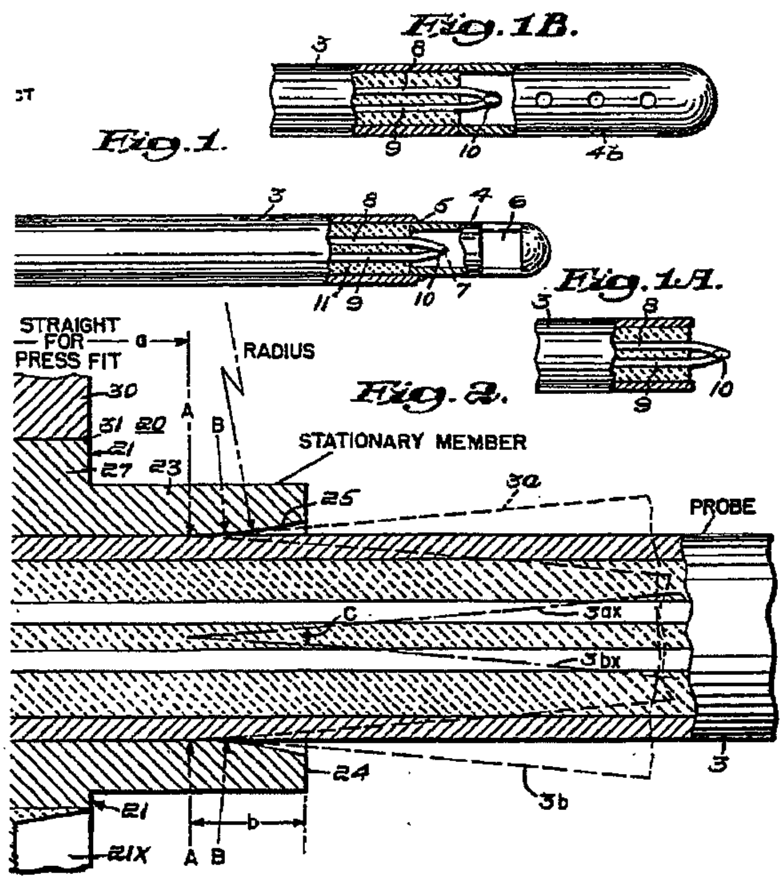

784,597 COMPLETE SPECIFICATION
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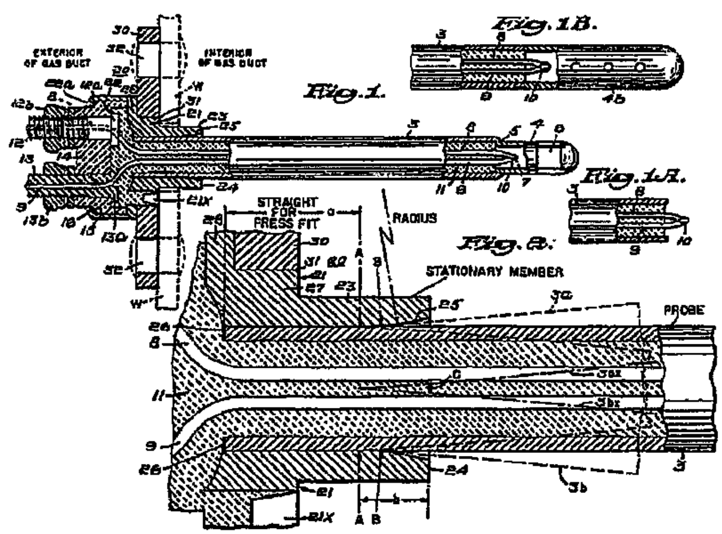


Nov. 30, 1971 R. P. BENEDICT 3,623,367

APPARATUS FOR MEASURING THE AVERAGE TEMPERATURE OF A GAS STREAM

Filed Dec. 23, 1969

FIG. 1

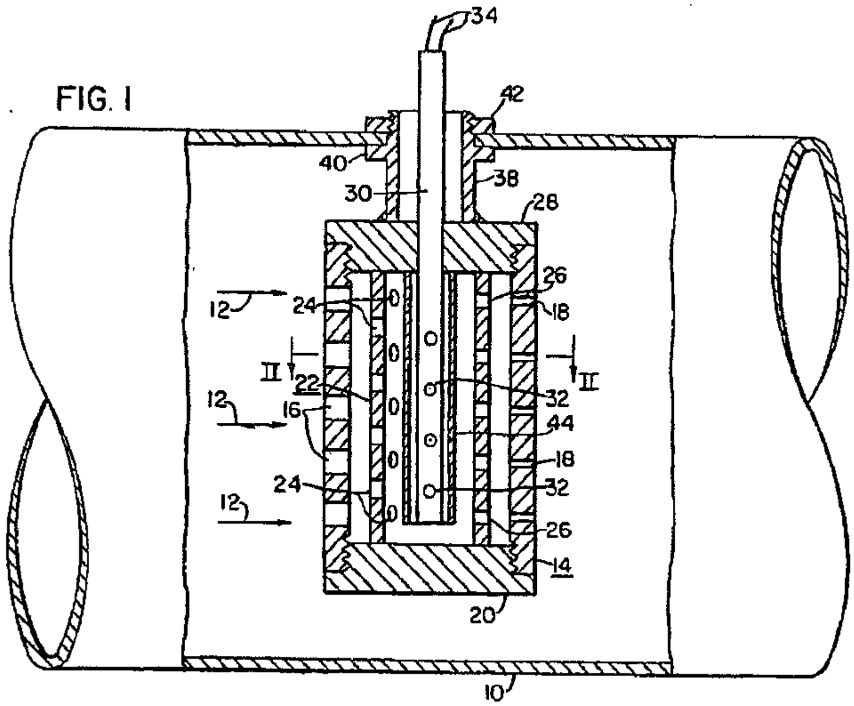
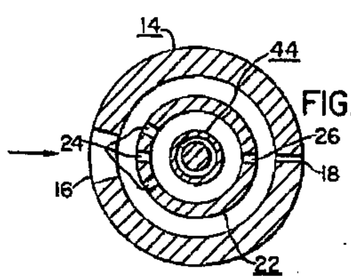


FIG. 2



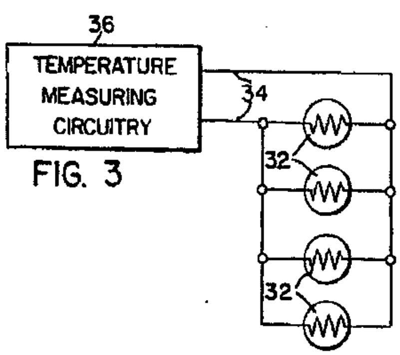


FIG. 3

FIG. 4